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TASK OUTLINE FOR USP-11 THERMOELECTRIC GENERATOR

I. AIM :

The aim of this task is the production of working prototype models, design information, and complete manufacturing drawings and specifications for a miniaturized thermoelectric D.C. generator to be employed as a charging unit for 6-volt storage batteries.

II. NOMENCLATURE :

The assigned nomenclature of this equipment shall be USP-11. Preliminary engineering models will be assigned the nomenclature USP-11X-1, -2, -3, etc., as may be necessary.

III. DISCUSSION OF THE TASK :

The task is to be conducted in two separate and distinct phases, a study phase and a design phase. The study phase is to be consummated prior to the initiation of the design phase. The study phase will investigate the following:

1. Types of thermoelectric emitters including recent developments of high output types.

2. A thermodynamic study of best methods of fuel utilization, heat flow, fireboz design, equalization of hot junction temperatures, cooling of cold junctions, and reduction of thermal gradient between hot and cold junctions.

3. An analysis of the generator system, including the effect of thermocouple resistance, internal power generation, and limitations of ambient temperature variations.

The study phase will be concluded by the submission of a report discussing the various thermo elements considered; the adaptability, or lack of, of each type; and a recommendation as to the best type or types with substantiating evidence as to the choice. The report will include the thermodynamic information and the system analysis of Sections 2 and 3 above.

Should the study phase indicate that technical or economic conditions obviate the possibility of manufacturing a device meeting the requirements outlined below, the reasons, limitations, and conditions shall be fully discussed in the report.

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The demonstration of the feasibility of the design will control the initiation of the engineering design phase. The purpose of the design phase is to provide all necessary design data, information, drawings, material lists, specifications, tolerances, and test procedures necessary to the manufacture of a preliminary engineering model of the equipment meeting the enumerated requirements as stipulated. The design phase is to be subdivided into the following periods:

Period 1. Preliminary Design.- This shall be a paper design of the equipment, based upon the results of the study phase and aimed at producing a set of drawings and specifications for the construction of the engineering model. Preliminary tests of components or units of the system shall be conducted to verify their suitability for the application. At the conclusion of this period, the design and data will be checked and evaluated by representatives of the Government.

Period 2. Engineering Model Construction and Tests.- During this period an engineering model shall be constructed, and complete tests shall be performed in accordance with the specification. The test shall be viewed and/or reviewed by representatives of the Government. The satisfactory completion of the specification tests shall precede the submission of the model to the Government for preliminary operational tests at Government operated laboratories.

Period 3. Production Prototype Design.- Upon completion of Government operational tests, estimated to require approximately thirty days, the Government may require changes or modifications in the equipment prior to production. The desired changes or modifications shall be transmitted in writing to the contractor who shall incorporate such changes into the design of the production prototypes. This period shall encompass all design changes necessary to producing a complete set of manufacturing drawings suitable for reproduction, a bill of material of all manufabricated parts and components including data as to capacity, tolerance, formula, composition, or definition, as may be required for purchasing. The manufacturer, or supplier, shall be identified, and the cost in some unit quantity shall be stated. Complete

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manufacturing instructions where applicable shall be included, as well as complete test procedures for prototype tests and production tests. The submission of a report giving the above requested information, the drawings, the complete revised specification, and five prototypes meeting the specification shall terminate the task. Acceptance tests of the five prototypes shall be conducted by the Government engineers at a Government test facility if available.

IV. PRODUCT REQUIREMENTS :

The controlling factors of this product design are in the following sequence of importance:

1. Reliability
2. Portability (Size and Weight)
3. Fuel efficiency and adaptability
4. Charging rate
5. Power efficiency (Internal Resistance)
6. Convenience (For cleaning, operation, instrumentation)

The specific requirements of the final product are enumerated below and shall act as a major influence on the preliminary studies and designs:

1. Shall be able to charge a 6-volt lead-acid storage battery of 100 amp hour size at a charging rate of 10 amps minimum when the specific gravity of the battery electrolyte is between 1150 and 1200.

2. Shall be adaptable to utilizing the heat generated by burning a wide range of fuel including wood, coal, charcoal, oil, or kerosene.

3. Shall include a charging rate indicator and a protective cut-out to prevent discharging the battery into the generator when the temperature of the thermocouples drops below that required to maintain a charging current. The functions of charge indication and cut-out protection may be combined.

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4. The maximum weight, when packed for transport, shall not exceed 15 pounds. The maximum transport size shall not exceed 24 inches long, 12 inches high, and 4 inches thick. The use of "knock-down and assembly" construction shall be permitted providing no malfunction of the equipment is caused and no limitation on operational adaptability ensues.

5. The design shall be such as to provide the specified charging rate with a hot junction temperature not exceeding 550° F. and an ambient temperature up to but not exceeding 100° F.

6. The fuel rate shall not exceed 20,000 BTU/hour for the 10 amp charging rate.

7. Suitable heat equalizing elements shall be used to prevent a temperature variation, between hot junctions, of more than 100° F. when measured between any two hot junctions.

8. Provisions shall be incorporated that will either: (1) permit simple cleaning of the thermocouples, or (2) prevent carbon, ash, or other deleterious material from being deposited on the thermocouples.

9. The internal resistance shall be limited to the greatest practical extent, in no case to exceed 0.2 ohms. All welded junctions shall be of minimum resistance. Cold junction construction shall be such as to preclude heating due to the charging current.

V. TEST PROCEDURE REQUIREMENTS :

The test procedures shall include, as a minimum, such tests as may be required to insure that the equipment meets all of the above requirements.

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